INTRODUCTION:

This introduction provides background on the use of radioactive materials and the various regulatory jurisdictions at the Boeing Santa Susana Field Laboratory (SSFL).

The site and operations at issue have been identified by a number of names over the years depending upon which company was the operator of the site at the time and the location or part of the site referenced. Among the names associated with the site are Rockwell, Rocketdyne, Boeing (the current site operator), SSFL, and Energy Technology Engineering Center (ETEC). Only a portion of the site was licensed by the Department of Health Services (DHS), Radiologic Health Branch (RHB), and that area will be referred to as Rocketdyne.

The legal jurisdiction over activities involving the use of radioactive materials (including nuclear reactor fuels) at the site is split between three governmental entities, two federal and one state. Activities involving nuclear reactors and reactor fuels are regulated by the U. S. Nuclear Regulatory Commission (NRC). Activities involving other radioactive materials are regulated by the State of California's DHS' RHB. Also, certain activities involving nuclear reactors, their fuels, and other radioactive materials are carried out by Boeing (and its predecessor companies) under the status of a prime contractor of the U. S. Department of Energy (DOE; formerly the U. S. Energy Research and Development Administration, and prior to that the U. S. Atomic Energy Commission). The NRC and DHS were excluded from regulating those activities by the federal Atomic Energy Act of 1954. In particular, DOE's activities were conducted within a specified area inside the boundaries of SSFL under the name of ETEC; activities within this area were not subject to either NRC or DHS regulation.

Certain buildings and areas at Rocketdyne have been decontaminated and released for unrestricted use, while others have not yet been decontaminated and released for unrestricted use. The upper sodium burn pit, which was part of the Former Sodium Disposal Facility (FSDF), is located in the Rocketdyne area. Waste materials (including both hazardous and radioactive materials) were taken from within the ETEC area to the upper sodium burn pit. However, the radioactive materials in these wastes were DOE's and therefore not subject to regulation by either the NRC or DHS. The cleanup of these DOE wastes is being conducted under the DOE prime contractor status.

Prior to March 26, 1997, DHS used as a release standard for contaminated sites, including Rocketdyne, two guidelines. One was NRC Regulatory Guide 1.86 and, in particular, the table that specifies surface contamination limits for various radionuclides. NRC Regulatory Guide 1.86 provides a standard for release of facilities and equipment for unrestricted use that is based on surface contamination. The other measure used was the 100 mrem/yr dose limit for members of the general public which appears in the NRC regulations (10 C.F.R. § 20.1301) and which has been adopted by reference as a regulation in California. (Cal. Code Regs., tit. 17, §30253.) All decisions by DHS to approve release of material for unrestricted use at Rocketdyne which were made prior to March 26, 1997 were based on those two guidelines.

On March 26, 1997, DHS approved the request of DOE and Rocketdyne to establish a release standard of 15 mrem/yr for the Rocketdyne site. All authorizations by DHS after March 26, 1997 for release of material at Rocketdyne for unrestricted use were made according to the 15 mrem/yr standard.

NRC adopted a national limit of 25 mrem/yr for the release of sites for unrestricted use which became effective on August 20, 1997 and which the NRC began enforcing on August 20, 1998. (10 C.F.R. §20.1402 (1998).) DHS began applying the 25 mrem/yr standard on August 20, 1998. DHS has proposed an amendment to its regulations to adopt by reference, among other things, that portion of 10 Code of Federal Regulations, part 20, that sets the limit of the 25 mrem/yr dose, namely 10 C.F.R. §20.1402. Under the 25 mrem/yr standard, a site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a dose that does not exceed 25 mrem/yr and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).

DHS has been involved with the Rocketdyne site and material in three different ways. First, DOE and Boeing asked for "concurrence" from DHS in the sampling and analysis methods and the cleanup levels/limits for the DOE radioactive waste that was deposited in the upper sodium burn pit. This request was made to eliminate the need for a radioactive materials license from DHS after the DOE waste was cleaned up and this site had been released to private control.

Second, after DOE cleaned up the burn pit in question to the agreed-upon level, the burn pit reverted to California control. Boeing, in its effort to release parts of the SSFL site for unrestricted use, applied for the unrestricted release of the burn pit area. Based upon the agreed-upon release standard of 15 mrem/yr, DHS released the burn pit area for unrestricted use. The dose was evaluated using a residential scenario, which is considered to be the most limiting dose scenario. The reason it is considered the most limiting is that a family is assumed to have established residence on-site and to be consuming food grown on the site and drinking water from wells on-site. In addition, the family is assumed to be exposed to direct radiation and radon as well as ingesting and inhaling radioactive dust.

The third way in which DHS was involved relates to off-site disposal. Normally, DHS does not involve itself once a facility has been released for unrestricted use. However, in this case, DHS was asked to review the proposed shipment of the FSDF soil to a site not licensed for disposal of radioactive waste. The FSDF soil is intended to be removed in order to meet the soil concentration limits for non-radioactive hazardous materials at the site. The soil is intended to be shipped to a hazardous waste disposal site. DTSC asked DHS to confirm that this soil could go to a hazardous waste site. DHS confirmed that it had released the site for unrestricted use and therefore DHS would not prohibit that soil from going to a hazardous waste site.

All decisions by DHS to release decontaminated facilities, equipment, and sites are based upon projected radiation doses. At the present time, as noted above, the

standard for release of sites for unrestricted use is set by the NRC at 25 mrem/yr based upon an all-pathway dose analysis.

On the other hand, decisions by DHS to approve an alternate method of disposal of radioactive material other than from a site that has been released for unrestricted use by DHS, are made on a case by case basis. A dose level of 1 mrem/yr is defined by the National Council on Radiation Protection and Measurements in its Report No. 116 as a "negligible individual dose." DHS uses this level when reviewing requests for alternate methods of disposal. DHS considers that the 1 mrem/yr dose limit clearly demonstrates that there is no significant health or safety risk. The procedure by which DHS grants authority to approve alternate methods of disposal of radioactive material is found in 10 C.F.R. §20.2002 (1998), which has been incorporated by reference in California by title 17, California Code of Regulations, section 30253.

As for recycling, there is no national standard for the recycling of slightly radioactive materials. The NRC is currently in the process of attempting to set such a standard through the regulation adoption process. It is important to point out that the Rocketdyne situation does NOT involve recycling.

RESPONSES TO QUESTIONS POSED BY SENATOR BOXER AND SENATOR KUEHL:

(1) Is local background or national background the measure applied by DHS and/or the federal agencies when determining whether waste is contaminated by radionuclides? Please cite to legal requirements or policy documents, if any exist.

The regulatory standard of 25 mrem/yr for release of a site is based on the residual radioactivity that is distinguishable from background radiation. This standard is found in 10 Code of Federal Regulations, section 20.1402, which DHS is proposing to adopt by reference by amending the California Code of Regulations, title 17, section 30253. In determining this residual radioactivity, DHS uses local background, when available. When local background is not available, DHS uses national background.

As noted above, the 15 mrem/yr release standard was established for the Rocketdyne area prior to the NRC establishing 25 mrem/yr as the national standard and DHS using the 25-mrem/yr standard in its release determinations. Additionally, DHS' actual release of the sodium burn pit soils was based on analytical results that show that the actual residual radioactivity of the soils above local background would result in a dose far less than 15 mrem/yr and as low as reasonably achievable. See the response to question 9(d).

(2) Is it California's policy to permit materials (i.e. materials from operation or cleanup of nuclear facilities, rather than waste from biomedical institutions, hospitals, storage-to-decay operations, etc.) with measurable radioactive contamination above local background levels to be:

(a) disposed of at landfills not licensed to receive radioactive materials;
(b) provided to facilities such as scrap or metal recyclers for recycling into consumer products;
(c) released to schools, private property owners, or other entities not licensed for radioactive materials?

California's policy is that radioactive waste generated from operation or cleanup of facilities where radioactive materials are used or stored must be disposed of at sites authorized by DHS to receive radioactive waste. Such sites are not necessarily limited to licensed low-level radioactive waste facilities. In some cases, some of the waste contains very low concentrations of residual radioactivity. As stated above, persons may request approval by DHS of an alternate method of disposal, which relieves the party from radioactive waste disposal requirements for its material. The requester is required to provide sufficient data (i.e., survey and sampling data and risk assessment) and a disposal plan to DHS for review and evaluation. DHS verifies the data prior to granting permission for disposal of the material at a site not licensed to receive radioactive waste. DHS makes decisions on a case-by-case basis, based on the standards discussed in the response to question 3 below.

(a) Yes, DHS has granted permission as described above in cases where the DHS analysis indicated no significant risk to the public or the environment. See the introductory section and responses to questions 5, 7 and 10 for additional information about these DHS authorizations.

(b) California has not received a request for recycling of radioactive materials into consumer products.

(c) No, if that radioactive material poses a significant risk to the public health or the environment. If the material poses no significant risk to the public health or the environment, there is no restriction on the subsequent release of any material from operation or cleanup of nuclear facilities when that material has been decontaminated and authorized by DHS for unrestricted release. Therefore, if there is no significant risk to the public or the environment, private and public property owners or other entities not licensed for radioactive materials may choose to accept those materials.

(3) If California does have such policy of permitting disposal, release, or recycling of radioactively contaminated materials to facilities not licensed to receive or dispose of radioactive materials, please provide the statutes or regulations explicitly authorizing such release to these entities.

DHS will not permit disposal, release or recycling of radioactively contaminated material that poses a significant risk to public health or the environment.

Law and regulations authorizing disposal to facilities not licensed to receive or dispose of radioactive materials:

- California Health and Safety Code section 114715:

  "No person shall bury, throw away, or in any manner dispose of radioactive wastes within the State except in such a manner and at such locations as will result in no significant radioactive contamination of the environment."

- California Health and Safety Code section 114710(h):

  "Significant" or "significantly," as applied to radioactive contamination, means such concentrations of radioactive material as are likely to expose persons to ionizing radiation equal to or greater than the guide levels published by the Federal Radiation Council."

  Note: The Federal Radiation Council published Federal Radiation Guidance prior to 1970. The guidance, which sets the dose limit for the general public, was set at 500 mrem/yr. In 1970, the authority of the Federal Radiation Council was transferred to the U.S. Environmental Protection Agency (U.S. EPA). In 1994, U.S. EPA proposed that the 500 mrem/yr limit be reduced to 100 mrem/yr. This U.S. EPA proposal has not yet been finalized. This proposal, if finalized, would impose the same limit as NRC (10 C.F.R. §20.1301), DOE (DOE Order No. 5400.5), and current DHS policy, namely 100 mrem/yr. This should not be confused with the 25-mrem/yr standard used for release of sites for unrestricted use.

- 10 Code of Federal Regulations section 20.2002, incorporated by reference in California by California Code of Regulations, title 17 section 30253:

  "Method for obtaining approval of proposed disposal procedures.

  A licensee or applicant for a license may apply to the Commission for approval of proposed procedures, not otherwise authorized in the regulation in this chapter, to dispose of licensed material generated in the licensee's activities. Each application shall include:

(a) A description of the waste containing licensed material to be disposed of, including the physical and chemical properties important to risk evaluation, and the proposed manner and conditions of waste disposal; and

(b) An analysis and evaluation of pertinent information on the nature of the environment; and

(c) The nature and location of other potentially affected licensed and unlicensed facilities; and

(d) Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in this part."

- California Code of Regulations, title 17, section 30104:

"Exemptions.

(a) The Department may, upon application by any user, or upon its own initiative, grant such exemptions from the requirements of this regulation as it determines are authorized by law and will not result in undue hazard to health, life or property. Applications for exemptions shall specify why such exemption is necessary.

(b) Before granting an exemption, the Department shall determine that there is reasonable and adequate assurance that:

(1) the doses to any individual in any controlled area will not exceed those specified in section 30265;

(2) the dose to the whole body of any individual in any uncontrolled area will not exceed 0.5 rem a year;

(3) the deposition of radioactive material in the body of any individual will not likely result in a greater risk to the individual than would be expected from the dose specified in section 30104(b)(1) or (2), as appropriate, based on guidance from such bodies as the International Commission on Radiological Protection, and the National Council on Radiation Protection and Measurements; and

(4) There is no significant hazard to life or property."

Law and regulations authorizing releases to schools, private property owners, or other entities not licensed for radioactive materials:

California has authority to release for unrestricted use previously contaminated sites that have been decontaminated. (California Code of Regulations, title 17,

section 30256 and 10 Code of Federal Regulations, section 20.1402, which DHS is proposing to adopt by reference by amending California Code of Regulations, title 17, section 30253.) After such a site has been released, DHS's approval is no longer required for transfer of those materials to unlicensed entities.

Law and regulations authorizing recycling of radioactively contaminated materials into consumer products:

As stated above, California has never received a request to approve recycling of radioactively contaminated materials into consumer products. At the present time, California has no law or regulation specifically addressing this practice.

(4) If there is such a policy, please explain how such a policy is consistent with the DHS policy as described by DHS Director Bontá in her July 1, 1999, letter to the US Army Corps of Engineers over the Buttonwillow issue. That letter described that policy as follows:

> Please be advised that any radioactive materials, including naturally radioactive materials in concentrations exceeding the concentrations found in nature, are subject to regulation and licensing as radioactive materials in California.... Disposal of radioactive materials must be either at a site that is licensed by the Department to dispose of radioactive waste, or at a site otherwise approved by this Department, unless such disposal is at a site under exclusive federal jurisdiction.
>
> For any facility not licensed or otherwise exempted by this Department to receive, store or dispose of any radioactive waste, such disposal would be a violation of California law, and would subject a violator to potential monetary penalties and criminal prosecution.
>
> For these reasons, the Department hereby gives notice that it will not approve or authorize any shipments such as that which has recently occurred at Buttonwillow, and the Department strenuously objects to the U.S. Army Corps of Engineers transporting or authorizing transportation of radioactive waste disposal facilities in California.

There is no inconsistency. If the material does not pose a significant risk to the public or the environment, it may be approved by DHS for disposal by alternative methods other than radioactive waste disposal as described in section 20.002 of the NRC's regulations. (See response to question number 3 for a list of the statutes and regulations that are the foundation of this policy.) Dr. Bontá's letter is correct that all such material is subject to DHS regulation, whether approved for alternative disposal or not.

(5) Please provide any written licenses, exemptions or authorizations granted to the Kettleman City facility, the Bradley Landfill, the Santa Clara Ranch, or the Hugo-Neu Prowler metal recycling firm licensing or authorizing them to receive radioactive materials, or exempting them from the requirement for licensing to receive radioactive materials.

There are no explicit written licenses, exemptions or authorizations granted by DHS to the Kettleman City facility, the Bradley Landfill, the Santa Clara Ranch, or the Hugo-Neu Prowler metal recycling firm allowing them to receive radioactive waste materials. As explained above in the response to questions (3) and (4), DHS may authorize release of radioactive material to unlicensed entities if the material poses no significant risk to the public or environment.

No facility in California possessing or using radioactive materials is exempt from DHS licensing and regulation (Health & Saf. Code §115165), with the exception of those facilities under the jurisdiction and regulatory control of a federal agency such as the NRC or DOE. Furthermore, although the latter facilities are not licensed, DHS retains the authority to regulate any possessor of radioactive material subject to its jurisdiction.

(6) In 1993, DOE's James Davis wrote to DHS regarding allegations of illegal disposal of radioactive material from the SSFL burn pit at Kettleman City. In that letter, DOE stated that DOE facilities such as SSFL are "required to develop and implement a more stringent set of procedures to show that hazardous waste generated in these areas where radioactive materials were handled do not contain added radioactivity; if measurable radioactivity from DOE operations is found, then the wastes are to be managed as mixed waste.... Soil found to have any added radioactivity is segregated and managed as low level radioactive waste or mixed waste...."

How is the proposed shipment to Kettleman City consistent with this DOE statement?

With regard to any inconsistencies in DOE policies, please refer to the DOE's response to this question. Additionally, DHS believes that its activities have been consistent.

Regarding the previous disposal at the Kettleman City waste disposal facility, DHS concurred, after investigation, that the soil shipped to Kettleman City contained such a low concentration of radioactivity that the soil posed no significant risk to public health or the environment, and was not required to be buried in an authorized radioactive waste site. The soil was very close to background level.

The criteria for release in this case are based on dose (risk). The dose is calculated based on the amount of radioactivity above background. The particular background, whether that level is relatively high or low, is only considered as the baseline level, and is not added to the risk evaluation.

DHS concurs that the present proposed shipment of soil to Kettleman City is not required to be buried in an authorized radioactive waste site. DHS has determined that the alternative method of disposal of this soil does not pose a significant risk to public health and the environment.

(7) If California has a policy of permitting the release of radioactive material to be disposed of at non-NRC licensed facilities, please provide the written numerical standards by which decisions to authorize such releases is based (for both soils and other volumetrically contaminated materials) and the citation to the legal authority for those standards.

If the standard is whether radioactivity levels are above national background, please provide the rationale for adopting a national background standard rather than a local one.

As stated previously, DHS approves the release of sites for unrestricted use if the dose is calculated not to exceed 25 mrem/yr and is considered to be as low as reasonably achievable. The approved limit for release of the Rocketdyne site was 15 mrem/yr and was established prior to implementation of the 25-mrem/yr standard.

Radioactively contaminated material that does not come from a site that has been released for unrestricted use must be disposed of at a licensed low-level radioactive waste disposal facility unless an alternate method of disposal is approved. California has evaluated requests for alternate methods of disposal of radioactively contaminated materials on a case-by-case basis. All such requests have involved materials with very small amounts of radioactive contamination and most were also contaminated with hazardous materials. DHS authorized the disposal of these materials based upon an analysis of the potential dose that could result from the proposed disposal. These dose analyses were made assuming conservative all-pathway analysis. None of these alternate disposals resulted in a calculated dose of more than 1 mrem/yr to the maximally exposed individual. This compares favorably with the 15-mrem/yr limit that is applicable if the materials had been left on the Rocketdyne site rather than being shipped to a disposal site.

(8) Even if the standard for permitting these releases is whether the soils are above national background, how could such a release be permitted when DHS' data shows the burn pit soil samples are above national background, as well as local.

The national and state standards for release of a site for unrestricted use do not require a comparison of radiation levels at the site to background radiation levels. The DHS decision to release FSDF for unrestricted use was based on the dose assessment result, which shows that the actual residual radioactivity of the soils above local background would result in a dose that is much less than 15 mrem/yr.

Please see also the responses to questions 7, 9 (a), (d), (f), and (g) for an explanation of the national and state release standard.

(9) If the standard is, rather, whether the radioactivity levels are above the cleanup standards established by DOE for SSFL (15 mrem/yr dose estimate was stated as the standard on our call):

(9)(a) How is this to be reconciled with the fact that EPA has said that DOE's cleanup standards are insufficiently protective and violate CERCLAs requirement that DOE cleanup to EPA's higher standards?

The cleanup standard of 15 mrem/yr at Rocketdyne is below the national cleanup standard of 25 mrem/yr set by NRC. DHS cannot respond to allegations of an alleged dispute between DOE and U.S. EPA.

(9)(b) Why wouldn't this open the door to possible shipments from around the country to unlicensed landfills like the recent Army Corps shipments to Buttonwillow, or shipments nearly as radioactive?

Use of the 15 mrem/yr cleanup standard at Rocketdyne or use of the 25 mrem/yr cleanup standard would not "open the door" as suggested. As Dr. Bontá stated in her July 1, 1999 letter quoted in question number 4, DHS would have jurisdiction over and regulate all radioactive material entering the state for deposit in the state, except for material under federal jurisdiction. If, after investigation and analysis of the facts, DHS determined that the material posed no significant risk to the public or the environment, DHS may elect to approve alternate methods of disposal. If DHS determined that there was a significant risk to the public or the environment, DHS would then appropriately exercise its regulatory authority if it otherwise had jurisdiction. Because the Buttonwillow case is still under investigation, DHS declines to comment on that case.

(9)(c) Has DHS or any of the federal agencies done analyses of the doses to the public if the materials are released to particular landfills or recycled into consumer goods, as distinguished from doses if the soil and other materials were to remain in place at SSFL? (If so, please provide those analyses.)

As mentioned earlier, each proposal for an alternate method of disposal is evaluated on a case-by-case basis. Since the site in question had been released for unrestricted use, a dose calculation was not done for the disposal of the soil from that site. No plausible scenario has been suggested that would result in a higher dose to the public than was calculated for the materials being left in place on site. Since the materials were not being recycled, no evaluation of their being recycled was performed.

(9 ,d) Doesn't the data from the burn pit soils indicate doses in excess of the 15 mrem figure (e.g, K-40, Th-232); and from the radiological buildings torn down and shipped out (e.g., Bldg. 5, 26 mrem/yr above background)?

No, both the average and net average isotopic soil concentrations from samples collected by Boeing and DHS from the FSDF are all well below the DOE approved site-wide release criteria for soil concentrations. (Tables1 and 2.) This release criteria is based on a dose limit of 15 mrem/yr. Consequently, the dose calculated from the isotopic concentrations found at the FSDF is less than the DOE approved site-wide release criteria of 15 mrem/yr. (Table 3.)

DHS, using the RESRAD computer dose model, input the average soil concentrations in Table 1 for the FSDF. RESRAD estimates the potential annual radiation dose to a critical population group from exposure to such radiation. DOE requires RESRAD to be used to evaluate radioactively contaminated sites. NRC also approves RESRAD for dose evaluation by the licensees involved in decommissioning contaminated sites. DHS used the Boeing data rather than other data because the Boeing data was: 1) more conservative in that the data showed a higher concentration; and, 2) was more representative as there were more samples.

The soil concentrations of thorium and uranium, which are naturally occurring radioisotopes, are not significantly different from the background levels and, therefore, are not included in the dose calculation. The FSDF soil concentration for K-40, a naturally occurring radioisotope, shows a wider distribution than the local background distribution, but the average values for the data are similar, with a Boeing average value that is very slightly higher (0.31 pCi/g) than the background average value of 21.37 pCi/g.[1]

The dose resulting from the Cs-137 and Sr-90 average soil concentrations, which are not naturally occurring radionuclides, is 0.1644 mrem/yr (inclusive of the background concentration). Adding the dose resulting from the average soil concentration of K-40 to the doses resulting from the average soil concentration of Cs-137 and Sr-90 gives a total dose of 11.69 mrem/yr. These two dose values are inclusive of the background concentrations for these isotopes.

The dose resulting from the net average soil concentrations (exclusive of background concentration) for Cs-137 and Sr-90 isotopes is 0.003 mrem/yr. This dose is from Sr-90 only, as the average concentration for Cs-137 in the Boeing data is less than the average concentration of Cs-137 found in the background data. Background Cs-137 and Sr-90 appear to be due primarily to fallout from nuclear weapons testing. Adding the net average concentration of K-40 to the

[1] Because K-40 is a naturally occurring radionuclide, its concentration varies depending on geology. Therefore DHS, after discussions with U.S. EPA and DTSC, used only samples from geologically similar locations as that found at SSFL when it calculated the K-40 background level.

dose model with the net average concentration of Sr-90 gives a dose of only 0.1941 mrem/yr.

All of the calculated dose values, whether from the average data or the net average data, are well below the 15-mrem/yr value of the site-wide release criteria.

K-40, although a naturally occurring radioisotope, is used in this dose calculation because of concerns raised that the levels found at the FSDF are not at background levels.

Building # 5 of Rocketdyne was released on April 5, 1995, and prior to the establishment of the 15-mrem/yr limit that was agreed upon on March 26, 1997. Clearly, the release of Building # 5 for unrestricted use was not based on the 15 mrem/yr dose limit. Instead, it was based on the acceptable surface contamination limits specified in NRC's Regulatory Guide 1.86 and the dose limit of the members of the general public specified in the 10 Code of Federal Regulations, section 20.1301. The release of that building was in compliance with the RHB and NRC release criteria in effect at that time. The building was demolished in 1996, prior to the 15-mrem/yr agreement or the implementation of the NRC 25 mrem/yr NRC standard.

(9)(e) Doesn't DHS' own data summary (that which was discussed on the call) demonstrate that the soils exceed the EPA PRGs (e.g., strontium-90 at 13 times, potassium-40 at 1500 times, and thorium-232 at 450 times the EPA levels)? Even when background is subtracted, aren't the elevated readings substantially above the EPA PRGs.

The DHS comparison table (Table 2) does not, with the exception of K-40 as explained below, demonstrate that the net average soil concentrations exceed the U.S. EPA's Preliminary Remediation Goal's.

Two sets of numbers have been discussed; both are from the U.S. EPA Region 9. The first set, published by Steve M. Dean, U.S. EPA Region 9, December 18, 1996, is identified as Preliminary Remediation Goal (PRG) values. The PRG is a radionuclide's concentration in soil that generates a one in a million (1E-06 or $1x10^{-6}$) excess lifetime (defined by U.S. EPA as 30 years) cancer risk (cancer occurrences). "Cancer Risk" as defined in Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals) December 1991 (RAGS HHEM Part B), is the incremental probability of an individual's developing cancer over a lifetime (defined by U.S. EPA as 30 years) as a result of exposure to a potential carcinogen. This first set of numbers was generated from the U.S. EPA RISKCALC computer software based on RAGS HHEM Part B using default scenario values and the 1995 Health Evaluation Assessment Summary Tables (HEAST).

Tom Kelly, of U.S. EPA Region 9, provided the second set of numbers to the Santa Susana Field Laboratory Work Group as a table entitled "A Comparison of DOE Approved Cleanup Levels for ETEC, 10^{-6} Residential Levels and 'Background' Levels." (See Attachment C.) These numbers are not PRGs. According to footnote number 3 of that table, Tom Kelly's numbers are extrapolated from rural residential soil concentrations contained in *Radiation Site Cleanup Regulations: Technical Support Documentation for the Development of Radionuclide Cleanup Levels for Soil* (U.S. EPA 402/R-96/011A), September 1994.

The FSDF average and net average sample soil concentrations and the background soil concentrations are included in the following Tables 1 and 2 for comparison with U.S. EPA's two sets of numbers. Also included for comparison are the values from the DOE Approved Site-wide Release Criteria for the Santa Susana Field Laboratory (a dose based release criteria – 15 mrem/yr).

U.S. EPA's PRGs, as published by Mr. Dean, are shown in Tables 1 and 2 for Sr-90, K-40, Cs-137 and Th-232. A complete listing of these PRGs is found in Attachment B. Comparison of the PRG values with the soil net average concentrations (Table 2) indicates that the soil concentrations do not exceed Mr. Dean's PRG values with the exception of K-40, a naturally occurring radionuclide found in soils. The net background level for K-40 exceeds the PRG.

Table 1: Average Soil Concentrations as Sampled

Radionuclide	10^{-6} PRG Residential Soil [b] (pCi/g)	U.S. EPA 10^{-6} Level [a] (pCi/g)	Site-wide Release Criteria (pCi/g)	Background[d] (pCi/g)	Soil Concentration as Found	
					Boeing (pCi/g)	DHS (pCi/g)
Cs-137 D	0.0200	0.0100	9.2000	0.0930	0.0690	.0259
K-40	0.0680	0.0200	27.600	21.370	21.680	21.5800
Sr-90 D	14	0.0100	36	0.0570	0.1310	0.0430
Th-232	24	0.0030	5 & 15[c]	0.7940	1.3400	1.4050

[a] U.S. EPA 10^{-6} Level concentrations developed by Tom Kelly, U.S. EPA Region 9, based on Rural Residential Soil Concentrations contained in *Radiation Site Cleanup Regulations: Technical Support Documentation for the Development of Radionuclide Cleanup Levels for Soil* (U.S. EPA 402/R-96/011A), September 1994

[b] U.S. EPA Preliminary Remediation Goal's (PRG) as published by Steve M. Dean, U.S. EPA Region 9, December 18, 1996.

[c] DOE Order No. 5400.5 limits are proposed as 5 pCi/g averaged over the first 15 cm of soil depth and 15 pCi/g averaged over 15 cm layers below the top 15 cm.

[d] These figures are from McLaren-Hart, which was a consultant to ETEC. Values shown here represent the local background concentrations.

Table 2: Net Average Soil Concentrations (net → soil concentrations in excess of background levels)

Radionuclide	10^{-6} PRG Residential Soil [b] (pCi/g)	U.S. EPA 10^{-6} Level [a] (pCi/g)	Site-wide Release Criteria (pCi/g)	Background[e] (pCi/g)	Net Soil Concentrations [c]	
					Boeing (pCi/g)	DHS (pCi/g)
Cs-137 D	0.0200	0.0100	9.2000	0.0930	-0.0240	-0.0670
K-40	0.0680	0.0200	27.6000	21.3700	0.3100	0.2100
Sr-90 D	14	0.0100	36	0.0570	0.0734	-0.0149
Th-232	24	0.0030	5 & 15[d]	0.7940	0.5460	0.6110

[a] U.S. EPA 10^{-6} Level concentrations developed by Tom Kelly, U.S. EPA Region 9, based on Rural Residential Soil Concentrations contained in *Radiation Site Cleanup Regulations: Technical Support Documentation for the Development of Radionuclide Cleanup Levels for Soil* (U.S. EPA 402/R-96/011A), September 1994

[b] U.S. EPA Preliminary Remediation Goal's (PRG) as published by Steve M. Dean, U.S. EPA Region 9, December 18, 1996.

[c] A negative net concentration number indicates that the as found concentration value is below the background value for that isotope.

[d] DOE Order No. 5400.5 limits are proposed as 5 pCi/g averaged over the first 15 cm of soil depth and 15 pCi/g averaged over 15 cm layers below the top 15 cm.

[e] These figures are from McLaren-Hart, which was a consultant to ETEC. Values shown here represent the local background concentrations.

Table 3: Dose comparison

Site-wide Release Criteria (dose above background)	Average Soil Concentration (inclusive of background)	Average Soil Concentration w/ K-40 (inclusive of background)	Net Average Soil Concentration (exclusive of background)	Net Average Soil Concentration w/ K-40 (exclusive of background)
15 mrem/yr	0.1644 mrem/yr	11.6900 mrem/yr	0.0030 mrem/yr	0.1941 mrem/yr

(9)(f) If the standard proposed to being applied is that each shipment or practice (e.g., removal of the burn pit soil) can be shipped to facilities that are unauthorized or unlicensed to receive radioactive or mixed wastes if the material, had it been left in place, would meet the DOE 15 mrem/yr cleanup standard, wouldn't municipal landfills (or even schools or farms) be permitted to receive doses far in excess of the doses permitted for licensed radioactive waste facilities?

To clarify, it is our understanding that licensed facilities cannot result in more than 25-mrem/yr maximum dose to the public, from all shipments combined to such a facility over decades of operations. Under a 15 mrem/shipment standard, two shipments alone could result in an unlicensed facility being more dangerous than a licensed one. If this is the case, there would be no incentive for anyone to open a licensed or authorized facility since they could take more waste and have higher permitted exposures without a license. This would be, clearly, an inappropriate policy outcome. Further, isn't it the case that the 15 mrem/yr release criteria set for the assumption that the materials remain in place, whereas releasing such materials into schools, farms, metal recycling, etc. could cause substantially higher doses since those materials would not remain in place?

The radiation dose from multiple shipments of the same concentration of materials is not directly additive, nor is the radiation dose directly proportional to the volume of material deposited at a particular site. For example, using the concentrations of radioactive materials discussed previously, the dose in going from a hypothetical 10,000 cubic meters of soil to 1,000,000 cubic meters of soil increases by less than 5% for this 100 fold increase in quantity of material. Increases above that volume of 1,000,000 cubic meters adds very little additional radiation dose.

Therefore a dose, and resulting risk, an individual receives is dependent on the concentration of radioactivity in the particular volume of the material involved. For example, one gram of soil with a concentration of 10 picocuries per gram of radioactivity at a site will have practically the same radioactive concentration, and will produce approximately the same dose and risk, if deposited at a landfill. The effect is not cumulative at the landfill. If a ton of soil with that same radioactivity concentration is then added, the radioactive concentration at the landfill is only slightly increased. If added to material or soil with an identical concentration of radioactivity already at the landfill, the resulting total concentration at the landfill would be only slightly higher than the original 10 picocuries per gram. The area of radioactivity may increase, since there is now more mass involved, and perhaps a greater number of people could possibly be exposed if the material is spread over a larger area. However, only a very slight increase in dose is added to any one person occupying the landfill. Only when material is added with higher concentrations will the dose and risk significantly increase to an individual.

Also, the Rocketdyne cleanup standard is not 15 millirem per shipment, but rather 15 millirem per year. DHS employs the RESRAD model to calculate the dose to an individual. This model uses the radioactivity concentration level in excess of background at the particular site. This model takes into account all the essential pathways from which the individual may receive a radiation dose. The dose received from each pathway depends on the radioactivity concentration. Every shipment of soil removed from a particular site would have a similar radioactivity concentration. Thus, the dose at the disposal site will not be substantially greater than at the site of origin regardless of the number of shipments received. The dose at the disposal site would show a significant increase only if shipments with a higher radioactivity concentration were received. Therefore, it is not possible for any facility or disposal site that receives materials from sites released for unrestricted use under the 25 mrem/yr standard to exceed that cleanup standard, given the concentration levels involved here.

(9)(g) If the standard proposed to being applied is 1 mrem/yr, would not the same problems identified in (f) apply (e.g., 30 such shipments to an unlicensed facility would make it more dangerous than a licensed one)? Indeed, DHS had formally estimated doses from Ward Valley, if it had taken 5 million cubic feet of waste over 30 years, as approximately 1 mrem/yr. What is the rationale for permitting unlicensed facilities to take individual shipments that, when viewed cumulatively, are as dangerous as the federal and state governments estimated (in the case of Ward Valley) the entire risk from 30 years of massive shipments to a full-service, licensed LLRW facility? Finally, were the release criteria for buildings at SSFL that were demolished and sent out to unlicensed facilities such as municipal landfills set at 5 micro-rem per hour above background, or 44 mrem/yr, way over the 1 mrem/yr figure?

Again, as previously explained, successive shipments of material with like radioactivity will not significantly increase the dose or risk to an individual at the receiving site regardless of the number of shipments or amount of material shipped. In other words, the change in the resulting dose to a person at the site by the addition of material is principally dependent upon the radioactive concentration of the added material, not on the quantity of the radioactive material added. Only by adding material with higher radioactivity concentrations will the dose and resulting risk to an individual significantly increase. Also, the dose and risk at the deposit site will never be higher than the calculated dose and risk at the site from which that material is derived.

The current standard for licensed low-level radioactive waste disposal sites is not 1 mrem/yr. It is the NRC standard of not to exceed 25 mrem/yr as stated in 10 Code of Federal Regulations section 61.41. This was true for Ward Valley, as well as all other sites. Notwithstanding that agreed upon release criterion for this particular site, the dose resulting from the actual concentration levels of the FSDF soil was far below that level.

The standard for release of buildings at Rocketdyne was discussed in response to question 9 (d).

(10) If California has a policy requiring materials with measurable added radioactivity to be disposed of at a licensed facility, but permits exceptions, please provide the regulations identifying the numerical criteria for evaluating such exception requests.

Please also provide any written exception requests pursuant to those specific regulations, and any written decision to grant or deny those exception requests and the analysis performed to back it up, for any such shipment in the last five years from SSFL to Kettlemen City, Bradley Landfill, Hugo-Neu Prowler recycler, Santa Clara Ranch, or any other unlicensed recipient. In particular, please identify whether such an exemption request and grant occurred prior to shipment.

Please see the responses to questions numbered 2, 3, 5, and 7. Criteria for exempting material from the regulations is listed in response number 3. Within the last five years, DHS has not received or granted any requests for regulatory exemptions for the disposal of radioactive material for transfer of material from SSFL to an unlicensed disposal facility.

(11) In the early 1990s, Congress revoked the NRC's Policy on Below Regulatory Concern (BRC). NRC has now commenced a rulemaking that is considering whether to set standards that would permit release of contaminated materials. No such rule has yet been adopted. EPA has considered promulgating a rule that would permit certain levels of radioactive contamination in hazardous wastes that would be allowed to go to a hazardous waste disposal facility rather than an mixed waste facility. The proposed rule was sent back by OMB, and no such rule has been adopted. DOE promulgated a proposed rule, 10 C.F.R. 834, which would have provided regulatory approval for release of some contaminated materials for recycling and other disposal. The rule has never been adopted.

Moreover, the thrust of these regulatory proposals (i.e, to deregulate radioactive waste) has been the subject of serious criticism by Sens. Baucus (ranking member), Boxer, Lieberman, Reid and Moynihan, all of whom serve on the Senate Environment and Public Works Committee. Those senators have questioned whether it is appropriate to set such a deregulation standard at all.

In the absence of national standards, and in the apparent absence of explicit state standards, what is the State's basis for permitting releases of radioactively contaminated materials to unlicensed disposal facilities, schools, private property, and metal recyclers?

All authorizations for releases and alternate methods of disposal have been based upon evaluations of the potential dose to individuals derived from an all-pathway dose analysis. In making these decisions, DHS has relied upon the professional judgement of its staff and other experts in the field and has exercised its regulatory discretion. DHS would welcome a national standard against which to gauge its decisions. However, neither of the two federal agencies with responsibilities for setting national standards, U.S. EPA and NRC, has promulgated regulations in this area.

Please see also the responses to questions numbered 2, 3, 5, 7, and 9. Once again, DHS will continue to assert regulatory authority over any radioactive material in the state over which it has jurisdiction that is determined to be a risk to public health or to the environment.

(12) What is DTSC's legal authority for allowing the disposal of radioactive materials at disposal facilities under its jurisdiction? What is the origin of the 2000 picocurie standard in the Safety-Kleen Buttonwillow permit? What public health or other environmental analyses, if any, preceded the determination that hazardous waste facilities could safely handle disposal of such waste?

Legal Authority:

The Department of Toxic Substances Control (DTSC) has the legal authority to prohibit the presence of radioactive materials in the hazardous waste that it authorizes for disposal at permitted facilities. This authority is found in Health and Safety Code section 25200(c), which mandates DTSC to include in its permits "terms and conditions which DTSC determines necessary to protect human health and the environment." Additionally, DTSC permits for land disposal facilities make clear that the issuance of the permit does not release the Permitee from its duty to comply with all federal and state statutes and regulations and local ordinances applicable to the waste received at the facility. DTSC reads this permit provision together with the 2000 picocurie standard in the Safety-Kleen Buttonwillow permit to allow disposal of radioactive materials with activity levels less than 2000 picocuries per gram and not regulated by the NRC only when the disposal meets all applicable federal, state and local requirements applicable to the radioactive materials contained in the waste.

Origin of the 2000 picocurie per gram standard:

The original draft of the DTSC permit for the Safety-Kleen Buttonwillow facility did not contain the 2000 picocuries per gram limitation included in the final permit. The draft permit contained a provision that prohibited the disposal of radioactive materials regulated by the federal Nuclear Regulatory Commission or one of its Agreement States under the federal Atomic Energy Act (NRC-regulated radioactive materials). DTSC replaced this draft provision by the one containing the 2000 picocuries per gram limit in response to a comment that DTSC received when it circulated the draft permit for public comment. This comment related to screening for radioactivity in waste shipments to the facility. The 2000 picocurie per gram limit was inserted to address the screening issue. The 2000 picocurie per gram limit was also inserted to address naturally occurring radioactive materials (NORMs). NORMs are not regulated by the NRC, but may sometimes be contained in the oil field production-related hazardous wastes authorized for disposal at the facility by the DTSC permit.

Public Health or Environmental Analyses:

In issuing its permit, DTSC complied with the California Environmental Quality Act (CEQA). DTSC complied with CEQA by using the supplemental environmental impact report (SEIR) that had been certified by the Kern County Board of Supervisors for the conditional use permit that Kern County issued in conjunction with the issuance of DTSC's permit. Like the original draft DTSC permit itself, the Kern County conditional use permit evaluated in the SEIR only prohibited disposal of NRC-regulated radioactive

materials. This prohibition, expressly recognized in the SEIR, would have allowed the disposal of radioactive materials with radioactivity levels in excess of 2000 picocuries per gram. The permit provision in the final permit limits the allowable level to 2000 picocuries per gram.

The 2000 picocuries per gram limit was selected by DTSC in the absence of any federal or California regulatory standards for disposal of NORMs. This limit is the level of radioactivity above which shipments of NORMs would be required to be placarded as radioactive materials under U.S. Department of Transportation regulations (42 C.F.R. 173.403 (y)). With regard to other federal standards, DTSC's impression at that time was that U. S. EPA efforts to evaluate whether it should regulate the disposal of NORMs were focused on waste that exceeded 2000 picocuries per gram.

DTSC permits two other hazardous waste disposal facilities. Each permit contains a prohibition against disposal of NRC-regulated radioactive materials similar to the prohibition that was originally contained in the Buttonwillow permit. DTSC is working with DHS to evaluate whether these prohibitions, as well as the 2000 picocuries per gram prohibition in the Buttonwillow permit, should be made more stringent in view of the current level of knowledge about the risks associated with radioactivity not regulated by the NRC.

(13) DHS' own graphs indicate elevated levels of K-40, Cs, and Sr. Please explain the significance of these findings, or why they should not be considered significant.

K-40 is present at levels above both the national background range, and the local range. The explanation given on the conference call was that K-40 occurred naturally in the area. Ranges, by definition, account for random variation, and the explanation given only makes sense if the graph for K-40 represented an average, not a range.

The graphs presented in the May 2000 Work Group meeting showed a comparison of DHS' verification sample analysis of the Boeing FSDF soil data for K-40 to national and local background ranges.

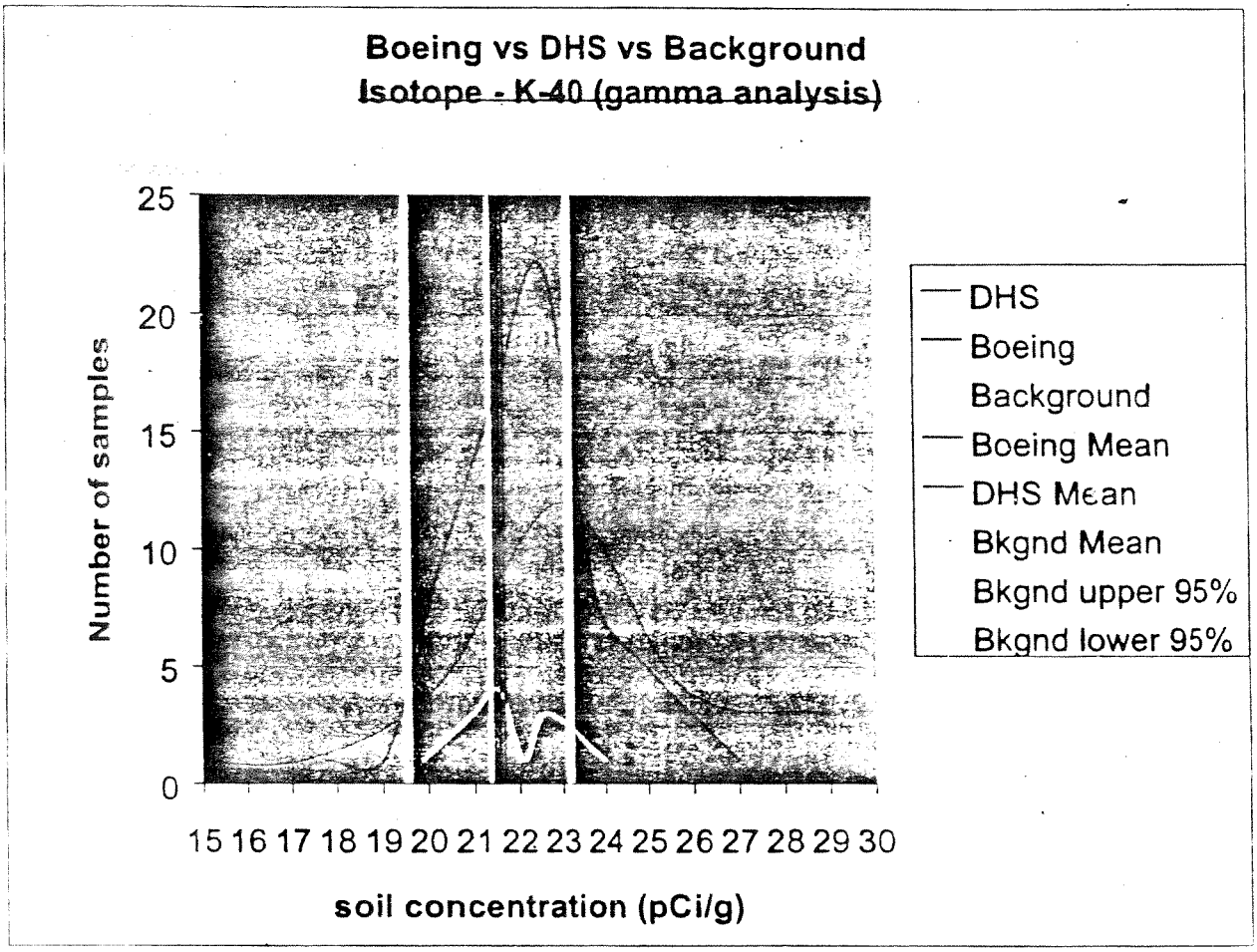
Regarding the national range, the graph shown at the meeting was based on Table 0-6 in a U.S. EPA report entitled "Technical Support Document for the Development of Radionuclide Cleanup Levels for Soil," EPA 402-R-96-011 A. This data is questionable. The range shown in that document is 3 pCi/g to 20 pCi/g. However, these data are unsupported. Since many of the background samples from the local area exceed the upper value of this range, the validity of this range is suspect. Additionally, another published national background range in Table 4.3 of NCRP Report # 94 shows an average background level for K-40 of 22.95 pCi/g in the continental upper crust; which is 1.58 pCi/g higher than the average K-40 local background at SSFL (21.37 pCi/g). This same table also shows a range for K-40 background concentrations in different types of rocks and soils of approximately 2 pCi/g to 40 pCi/g.

As for the local background, DHS performed a statistical analysis to determine the local background statistical range. (See Attachment A, Figures 1, 2 and 3.) That analysis shows statistical ranges for K-40, Cs-137 and Sr-90 based on two standard deviations of the averages for the above radionuclides (i.e. 95% confidence level). Thus, statistical ranges may not include all data. For example, in this case some of the DHS verification samples are below the local background range. This would not occur if the statistical range included all the samples.

Furthermore, rather than comparing data results to ranges, it is more meaningful to compare the averages to one another to obtain the net average. That comparison shows that the difference for K-40 is 0.31 picocuries per gram. (See Table 2.) That is an extremely slight difference. Therefore, the Boeing K-40 sampling data falls squarely within the local background range.

Attachment A

Figure 1: K-40



K-40 Low and High Values

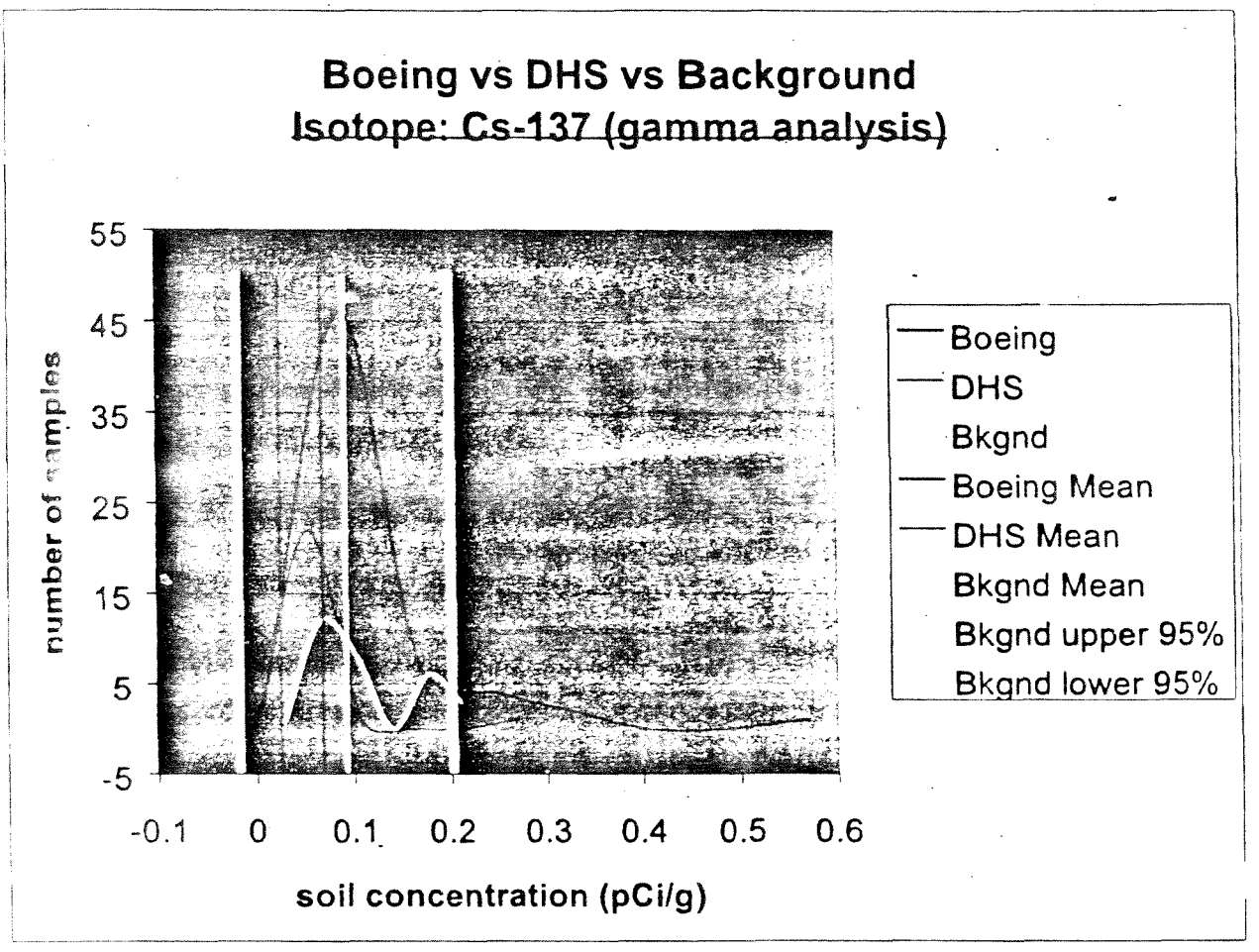
	McLaren-Hart pCi/g	Boeing pCi/g	DHS pCi/g
Low	19.9	20.04	14.43
High	23.2	23.91	28.72

K-40 Average Concentrations

	McLaren-Hart pCi/g ± 1.96σ	Boeing pCi/g	DHS pCi/g
Average	21.37± 1.745	21.68	21.58

Source: McLaren-Hart Study, Boeing FSDF Soil Sampling Results, and DHS Soil Verification Sampling Results

Figure 2: Cs-137



Cs-137 Low and High Values

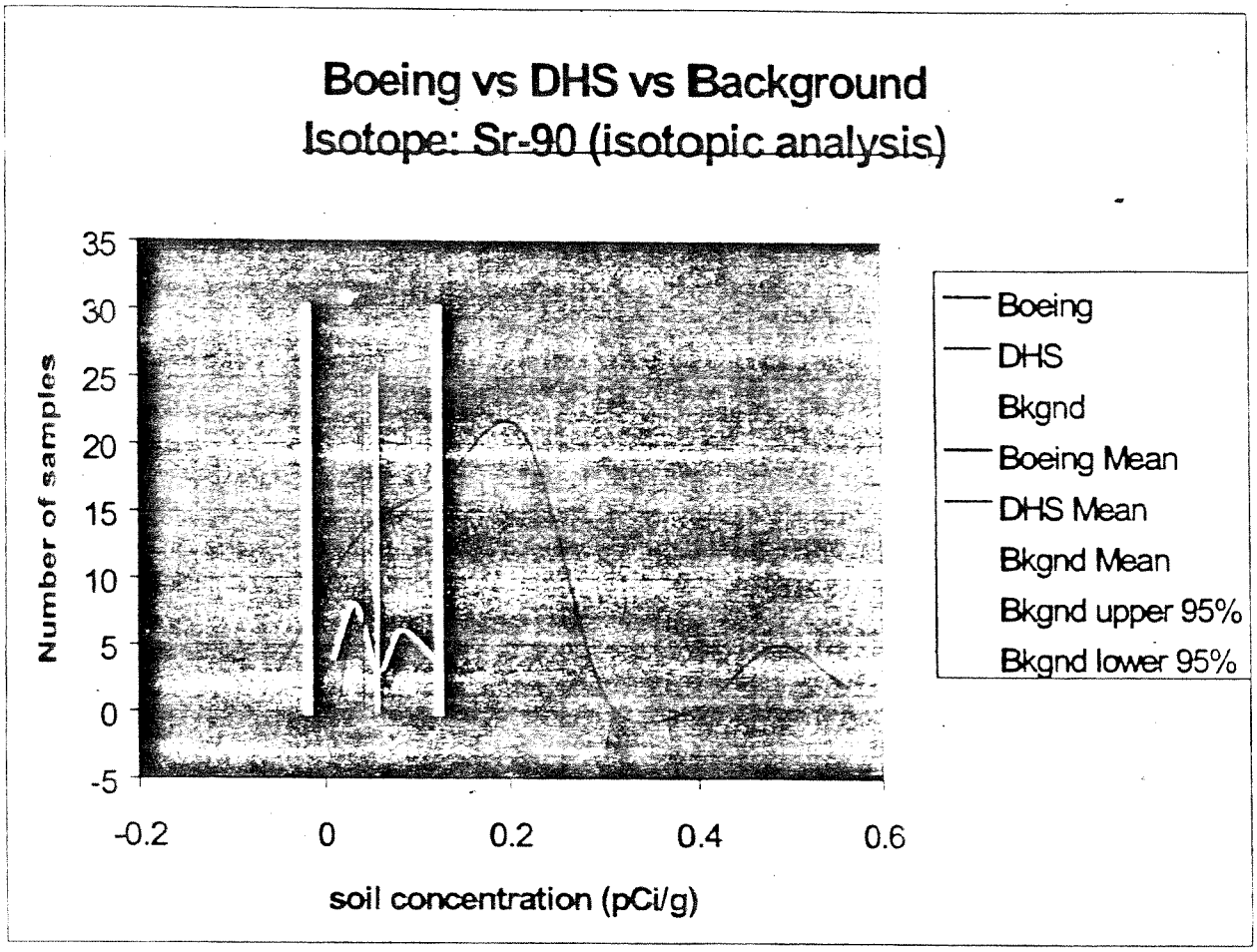
	McLaren-Hart pCi/g	Boeing pCi/g	DHS pCi/g
Low	0.03	0.008	0.0017
High	0.213	0.567	0.266

Cs-137 Average Concentrations

	McLaren-Hart pCi/g ± 1.96σ	Boeing pCi/g	DHS pCi/g
Average	0.0926 ± 0.1091	0.0688	0.0259

Source: McLaren-Hart Study, Boeing FSDF Soil Sampling Results, and DHS Soil Verification Sampling Results

Figure 3: Sr-90



Low and High Values

	McLaren-Hart pCi/g	**Boeing** pCi/g	**DHS** pCi/g
Low	0.0100	-0.0500	0.0175
High	0.1300	0.5690	0.0830

Average Concentrations

	McLaren-Hart pCi/g ± 1.96σ	**Boeing** pCi/g	**DHS** pCi/g
Average	0.0574 ± 0.0754	0.1308	0.0425

Source: McLaren-Hart Study, Boeing FSDF Soil Sampling Results, and DHS Soil Verification Sampling Results.

Attachment B

RADIONUCL.	COMMERCIAL SOIL					RESIDENTIAL SOIL				
	INGESTION	INHALATION	EXTERNAL	TOTAL	PRG (pCi/gram)	INGESTION	INHALATION	EXTERNAL	TOTAL	PRG (pCi/gram)
Ni 59	5.8E-11	1.1E-14	0.0E+0	5.8E-11	17000	2.3E-10	1.4E-14	0.0E+0	2.3E-10	4300
Ni 63	1.7E-10	2.7E-14	0.0E+0	1.7E-10	5800	6.9E-10	3.4E-14	0.0E+0	6.9E-10	1400
Np 237 D	9.4E-08	9.3E-10	3.1E-06	3.2E-06	0.32	3.8E-07	1.2E-09	1.1E-05	1.1E-05	0.087
Pa 231	4.7E-08	6.5E-10	1.8E-07	2.3E-07	4.4	1.9E-07	8.2E-10	6.5E-07	8.4E-07	1.2
Pb 210 D	3.2E-07	1.0E-10	9.7E-10	3.2E-07	3.2	1.3E-06	1.3E-10	3.5E-09	1.3E-06	0.78
Pu 238	9.2E-08	7.4E-10	1.3E-10	9.3E-08	11	3.7E-07	9.3E-10	4.7E-10	3.7E-07	2.7
Pu 239	9.9E-08	7.5E-10	8.4E-11	1.0E-07	10	4.0E-07	9.5E-10	3.0E-10	4.0E-07	2.5
Pu 240	9.8E-08	7.5E-10	1.2E-10	9.9E-08	10	4.0E-07	9.5E-10	4.5E-10	4.0E-07	2.5
Pu 241	1.6E-09	7.6E-12	0.0E+0	1.6E-09	610	6.6E-09	9.6E-12	0.0E+0	6.6E-09	150
Pu 242	9.4E-08	7.1E-10	1.0E-10	9.5E-08	11	3.8E-07	9.0E-10	3.7E-10	3.8E-07	2.6
Ra 226 D	9.3E-08	7.4E-11	4.5E-05	4.5E-05	0.022	3.7E-07	9.4E-11	1.6E-04	1.6E-04	0.0062
Ra 228 D	7.8E-08	2.7E-11	2.2E-05	2.2E-05	0.046	3.1E-07	3.4E-11	7.9E-05	7.9E-05	0.013
Sb 125	9.3E-10	1.4E-13	8.9E-06	8.9E-06	0.11	3.7E-09	1.8E-13	3.2E-05	3.2E-05	0.031
Sm 151	1.4E-10	1.2E-13	1.9E-12	1.5E-10	6900	5.8E-10	1.6E-13	7.0E-12	5.9E-10	1700
Sr 90 D	1.7E-08	1.9E-12	0.0E+0	1.7E-08	57	7.0E-08	2.4E-12	0.0E+0	7.0E-08	14
Th 228 D	7.2E-08	2.6E-09	6.6E-06	6.7E-06	0.15	2.9E-07	3.3E-09	2.4E-05	2.4E-05	0.041
Th 230	1.2E-08	4.6E-10	2.9E-10	1.2E-08	80	4.7E-08	5.9E-10	1.1E-09	4.9E-08	20
Th 232	1.0E-08	5.2E-10	1.3E-10	1.1E-08	92	4.1E-08	6.6E-10	4.7E-10	4.2E-08	24
U 234	1.4E-08	3.8E-10	1.4E-10	1.4E-08	69	5.6E-08	4.8E-10	5.1E-10	5.7E-08	18
U 235 D	1.5E-08	3.5E-10	1.8E-06	1.8E-06	0.57	5.9E-08	4.4E-10	6.4E-06	6.4E-06	0.16
U 238 D	1.9E-08	3.3E-10	3.8E-07	4.0E-07	2.5	7.8E-08	4.2E-10	1.4E-06	1.4E-06	0.69

D after the radionuclide means that its decay daughters are included in the risk calculations.
*The PRG is a radionuclide's concentration in soil that generates a one in a million (1E-06) lifetime cancer risk.
†For more information regarding RISKCALC contact Steve M, Dean, US EPA Region 9 (415) 744 1045.

Title and Source: "Risk Comparison For Radionuclides in Soil," provided by U.S. EPA Region IX.

Attachment C

A Comparison of DOE Approved Cleanup Levels for ETEC, 10^{-6} Residential Levels and "Background" Levels

Radionuclide	DOE Cleanup Level for ETEC[1] pCi/g (est. risk level[2])	EPA 10^{-6} Level[3] pCi/g	Background[4] (95% of distribution, not mean) pCi/g
Am-241	5.44 ($6x10^{-6}$)	0.90	
Co-60	1.94 ($5x10^{-4}$)	0.004	
Cs-134	3.33 ($3x10^{-4}$	0.01	
Cs-137	9.20 ($9x10^{-4}$)	0.01	0.21
Eu-152	4.51 ($5x10^{-4}$)	0.01	
Eu-154	4.11 $4x10^{-4}$	0.01	
Fe-55	629,000 ($9x10^{-3}$)	67.62	
H-3	31,900 ($3x10^{-6}$)[5]	11,000[5]	0.525
K-40	27.6 ($1x10^{-3}$)	0.02	
Mn-54	6.11 ($6x10^{-4}$)	0.01	
Na-22	2.31 ($6x10^{-4}$)	0.004	
Ni-59	151,000 ($2x10^{-2}$)	8.97	
Ni-63	55,300 ($2x10^{-2}$)	2.86	
Pu-238	37.2 ($4x10^{-5}$)	1.01	0.07
Pu-239	33.9 ($3x10^{-5}$)	1.04	
Pu-240	33.9 ($3x10^{-5}$)	1.04	
Pu-241	230 ($7x10^{-6}$)	30.76	
Pu-242	35.5 ($3x10^{-5}$)	1.09	
Ra-226	5 and 15 ($5x10^{-5}$ and $2x10^{-4}$)	0.1 (includes risk from decay to radon)	
Sr-90	36 ($4x10^{-4}$)	0.01	0.12
Th-228	5 and 15 ($5x10^{-4}$ and $2x10^{-3}$)	.01	1.7 (TMA) 0.9 (Teledyne)[6]

Radionuclide	DOE Cleanup Level for ETEC[1] pCi/g (est. risk level[2])	EPA 10^{-6} Level[3] pCi/g	Background[4] (95% of distribution, not mean) pCi/g
Th-232	5 and 15 ($2x10^{-3}$and $6x10^{-3}$)	0.003	1.58 (TMA) - 1.1 (Teledyne)[6]
U-234	30 ($6x10^{-4}$)	0.05	2.2 (TMA) 0.79 (Teledyne)[6]
U-235	30 ($8x10^{-4}$)	0.04	0.1 (TMA) 0.04 (Teledyne)[6]
U-238	35 ($9x10^{-4}$)	0.04	1.8 (TMA) 0.84 (Teledyne)[6]

[1]From the Proposed Sitewide Release Criteria for Remediation of Facilities at the SSFL, August 22, 1996. DOE approved the release criteria on September 17, 1996. DHS approved the release criteria on August 6, 1996.

[2] Estimated by comparison with Rural Residential (~~10^{-4} level~~) contained in Radiation Site Cleanup Regulations: Technical Support Document for the Development of Radionuclide Cleanup Levels for Soil (EPA 402/R-96/011A), September 1994

[3] Based on Rural Residential Soil Concentrations (~~10^{-4} level~~) contained in Radiation Site Cleanup Regulations: Technical Support Document for the Development of Radionuclide Cleanup Levels for Soil (EPA 402/R-96/011A), September 1994

[4] 95% (confidence interval) of the distribution, from the Area IV Radiological Characterization Study, August 15, 1996

[5] Based on Steve Dean's Risk Comparison for Radionuclides in Soil, derived from RiskCalc software using RAGS HHEM Part B with its Default Scenario Values. According to footnote 3, the 10^{-4} rural residential concentration is 34 pCi/g. However, this level seems suprisingly low considering that EPA's MCL for tritium is 20 pCi/g (20,000 pCi/l).

[6] The averages from both laboratories should be combined. Any samples collected outside the Chatsworth Formation should not be considered background for these radionuclides.

likely contaminants of concern

Source: DOE and U.S. EPA